CanSat 2023
Critical Design Review (CDR)
Outline
Version 1.0

No. 2022ASI-053

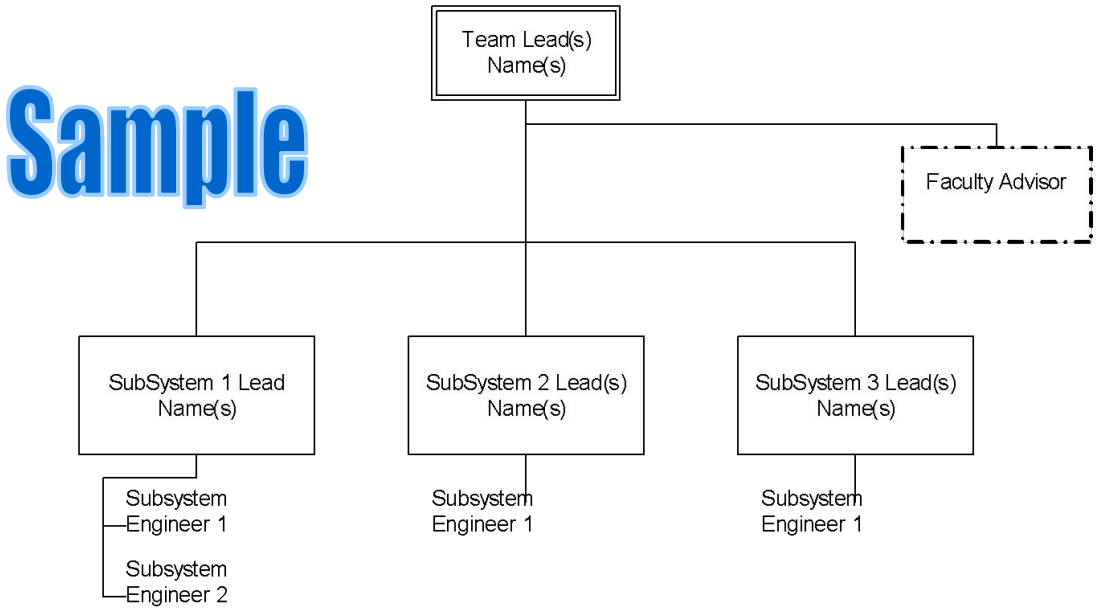
Team NMITSat

Presentation Outline

- **Provide a simple outline of the presentation**
- **Indicate the team member(s) who will be presenting each section**
- **Terms:**
  - ***Container*** refers to the ***container*** component of the CanSat
  - ***Payload(s)*** refers to the ***Science Payloads (i.e., the maple seed glider)*** components of the CanSat

Team Organization

- **Single slide listing the team members and their roles**
  - If possible, please include year (freshman, sophomore, etc.) for reference
  - This only needs to be provided once for team members showing up multiple times on the org chart
- **Good format is the use of an organization chart, such as below:**



Acronyms

- **Provide a list of acronyms used throughout the presentation**
  - During presentations, do not read through these acronyms
    - These are for reference only

The purpose of this section is to introduce the reviewer to the overall requirements and configuration of the CanSat. This provides a basis for the details presented in the subsystem sections.

System Overview

Presenter Name(s) Go Here

Mission Summary

- **Overview of the mission objectives**
- **Indicate whether selectable objective (bonus) is being attempted**
  - Describe selection rationale
- **Include any external objectives (personal, laboratory or sponsor, class, etc.) relevant to the design**

Summary of Changes Since PDR

- **Overview design changes since PDR**
- **Details of the changes are discussed in subsequent sections**
- **In every section, the summary of changes since PDR should be detailed in a separate slide, or indicate that there were no changes.**

System Requirement Summary

- **Overview of system (mission) level requirements**
  - Use bullets or a table to demonstrate an understanding of the mission requirements
  - Do not include all requirements, just high level system level requirements the describe the overall mission
- **The purpose of the table is to demonstrate the team understands the system-level requirements**
- **This table may be expanded to multiple tables as needed**

System Concept of Operations (CONOPS)

- **Slide(s) providing overview of CanSat operations**
- **Include:**
  - Pre-launch activities
  - Launch and descent operations
    - Be sure to include Payload operations
  - Post-launch recovery and data reduction
- **Focus on launch day activities**
- **Team member roles and responsibilities on launch day**
- **Simple flow diagrams and cartoons are a good way to present the CONOPS**
  - Absolutely no hand-drawn diagrams
  - Photos are acceptable

Payload Physical Layout

- **The goal is to present the physical idea of what the CanSat will look like for reference prior to getting into details of the CanSat design**
- **Diagram(s) showing physical layout of selected CanSat configuration**
- **Make sure to include:**
  - Dimensions
  - Placement of major components
    - Sensors, electronics, radio, power, mechanisms
  - Relevant configurations
    - Payload, launch configuration, deployed, etc.

Launch Vehicle Compatibility

- **Include a dimensioned drawing that shows *clearances* with the payload section**
  - Focus on launch configuration (Container + Payload)
  - Include all descent control apparatus (no sharp protrusions)
  - What is the clearance? (Leave margin to allow *easy* deployment!)
- **Notes:**
  - In past years there were a large number of CanSats that did not deploy from the payload sections of the rocket because of protrusions or because the CanSat was too wide to fit in the rocket
  - Lack of sharp protrusions and fit within the Launch Vehicle will also be scored at the Flight Readiness Review

Sensor Subsystem Design

Presenter Name(s) Go Here

Sensor Subsystem Overview

- **One slide providing an overview of the CanSat sensor subsystem**
  - Include summary of the selected sensors (type & models)
  - Include brief discussion of what the sensors are used for
  - Focus on selected component (not all components trades)

Sensor Changes Since PDR

- **One slide providing an overview of the CanSat sensor system changes since PDR**
  - Include rationale
  - Clearly explain why changes were made, including things like:
    - Power limitations
    - Testing
    - Component size
    - Availability

Payload Air Pressure Sensor Summary

- **Summary of altitude sensor selection and characteristics**
- **Include:**
  - Sensor accuracy and data format
  - Overview of data processing (including equations, as appropriate)
  - If there is no sensor, have a page that states it to receive the points

Payload Air Temperature Sensor Summary

- **Summary of temperature sensor selection and characteristics**
- **Include:**
  - Sensor accuracy and data format
  - Overview of data processing (including equations, as appropriate)
  - If there is no sensor, have a page that states it to receive the points

Payload GPS Sensor Summary

- **Summary of GPS sensor selection and characteristics**
- **Include:**
  - Sensor accuracy and data format
  - Overview of data formats (including equations, as appropriate)

Payload Voltage Sensor Summary

- **Summary of battery voltage sensor selection and characteristics**
- **Include:**
  - Sensor accuracy and data format
  - Overview of data processing (including equations, as appropriate)

Payload Tilt Sensor Summary

- **Summary of sensors selected to determine payload tilt upon landing (for purposes of leveling)**
- **Include:**
  - Sensor accuracy and data format
  - Overview of data formats (including equations, as appropriate)

Camera Summary

- **Summary of camera selection and characteristics**
- **Include:**
  - Ensure your camera meets the requirement of 640x480 pixels in color

Bonus Camera Summary

- **Summary of camera selection and characteristics**
- **Include:**
  - Ensure your camera meets the requirement of 640x480 pixels in color

Descent Control Design

Presenter Name(s) Go Here

Descent Control Overview

- One slide providing an overview of the Container and Payload descent control system
- Include overview of the selected configurations and components necessary
- Include diagrams outlining descent control strategy for various flight altitude ranges

Descent Control Changes Since PDR

- List changes since the PDR
- Include rationale
- Prototype testing

Container Descent Control Hardware Summary

- **Describe container descent control hardware**
  - Explain how descent control hardware works
  - Component sizing
  - Key design considerations
  - Color selection(s)
- **This discussion can carry over to multiple slides if necessary**

Payload Aerobraking Descent Control Hardware Summary

- **Describe payload descent control hardware**
  - Explain how descent control hardware works
  - Component sizing
  - Key design considerations
  - Color selection(s)
  - Dimensions and angles
- **This discussion can carry over to multiple slides if necessary**

Payload Descent Stability Control Design

- **Describe how the payload is kept pointing nadir and not tumble**
  - Describe mechanisms used
  - Describe how payload is kept nadir pointing
  - Show design of method
  - Active or passive stability control

Payload Parachute Descent Control Hardware Summary

- **Describe payload descent control hardware**
  - Explain how descent control hardware works
- **If using passive components, discuss:**
  - Component sizing
  - Key design considerations
  - Color selection(s)
- **If using active components, discuss:**
  - Sensor accuracy and data formats
  - Overview of sensor data processing
- **This discussion can carry over to multiple slides if necessary**

Descent Rate Estimates

- **Present descent rate estimates for the following CanSat configurations**
  - Container with payload
  - Payload Aerobraking
  - Payload Parachute release
- **Include discussion of**
  - Calculations used
  - Assumptions
- **This discussion can carry over to multiple slides if necessary**
- **Last slide summarizes results. Make sure final results are clearly identified.**

Mechanical Subsystem Design

Presenter Name(s) Go Here

Mechanical Subsystem Overview

- **One slide providing overview of the mechanical subsystem**
  - Include overview of major structural elements, material selection, and interface definitions
  - Include Container and Payload mechanical configurations

Mechanical Subsystem Changes Since PDR

- **Highlight mechanical changes since PDR. Details should be discussed on subsequent slides**

Container Mechanical Layout of Components

- **Show structure (CAD model)**
  - include dimension drawings
- **Identify location of electrical components**
- **Identify container attachment points**
- **Identify major mechanical parts**
  - mechanisms such as springs, hinges, etc.
- **Structural material selection(s)**

Container Parachute Attachment Mechanism

- **Describe how the parachute is attached to the Container and how parachute will deploy**
  - Include:
    - Diagrams
    - Description of operation
    - Material of container structure parachute is attached

Payload Mechanical Layout of Components

- **Show structure (CAD model)**
  - include dimension drawings
- **Identify location of electrical components**
- **Identify payload attachment points**
- **Identify major mechanical parts**
  - mechanisms such as springs, hinges, etc.
- **Structural material selection(s)**

Payload Pre Deployment Configuration

- **Show payload in stowed configuration**
  - Explain how the payload is secured in place.
  - How are all parts held in the stowed position.

Payload Aerobraking Deployment Configuration

- **Show payload in deployed configuration**
  - Explain any changes to the payload configuration when it is released.
  - Explain release mechanisms

Payload Parachute Deployment Configuration

- **Show parachute mechanical design**
  - Explain how parachute is stowed
  - Explain how parachute is released

Container Payload Mount

- **Show how payload is secured in the container.**
- **Show how the payload is released from the container.**

Structure Survivability

- **As applicable for the Payload and Container, discuss:**
  - Electronic component mounting methods
  - Electronic component enclosures
  - Acceleration and shock force requirements and testing
  - Securing electrical connections (glue, tape, etc.)
    - Consider required judge verification during pre-flight check in
  - Descent control attachments

Mass Budget

- **Table(s) providing the following:**
  - Mass of each component of payload and container
  - Mass of each structural element
  - Sources/uncertainties – whether the masses are estimates, from data sheets, measured values, etc.
  - Total mass of all components and structural elements
  - Margin : The amount of mass (in grams) in which the mass budget meets, exceeds, or falls short of the mass requirement
- **Method of correction to meet mass requirement (based on the margin listed above)**
- **Must clearly distinguish between Container and Payload masses**

Communication and Data Handling (CDH) Subsystem Design

Presenter Name(s) Go Here

CDH Overview

- **One slide providing overview of the CDH subsystem**
  - Should include selected components (with brief mention of what each component is for)

CDH Changes Since PDR

- **List changes to the CDH since PDR. Details of the changes should be discussed in subsequent slides**

Payload Processor & Memory Selection

- Include boot time
- Include processor speed
- Include data interfaces (types and numbers)
- Include memory storage requirements, if applicable

Payload Real-Time Clock

- **Describe design for Payload real-time clock**
  - Hardware clock with independent power supply
  - Reset tolerance
  - Real time clock should have independent battery backup to maintain time through power transients

Payload Antenna Selection

- **Description and characteristics of the antenna selected for the CanSat**
- **Discuss:**
  - Performance
  - Mass
-

Payload Radio Configuration

- **XBEE radio selection**
- **NETID setting**
- **Include transmission control**
  - How is this managed during each mission phase?
- **Note:**
  - Communications failures have occurred often over the past several years of the competition
  - You are encouraged to use your radios in all of your development and testing to better ensure mission success
    - Ideally you have started working with the radio and communications protocol

Start Radio Prototyping and Testing Early!

Payload Telemetry Format

- **What data is included?**
  - **Check the competition guide for telemetry requirements**
- **Data rate of packets?**
- **How is data formatted?**
  - Include example frames with complete descriptions
    - Include Container frames and Payload relay frames
  - *Does the presented format match the Competition Guide requirements?*

Payload Command Formats

- **List all supported commands with examples**
- **What data is included?**
  - Check the competition guide for command requirements
- **How is command data formatted?**
  - Include example commands with complete descriptions
  - *Does the presented format match the Competition Guide requirements?*

Electrical Power Subsystem Design

Raj Pratap Vidyarthi

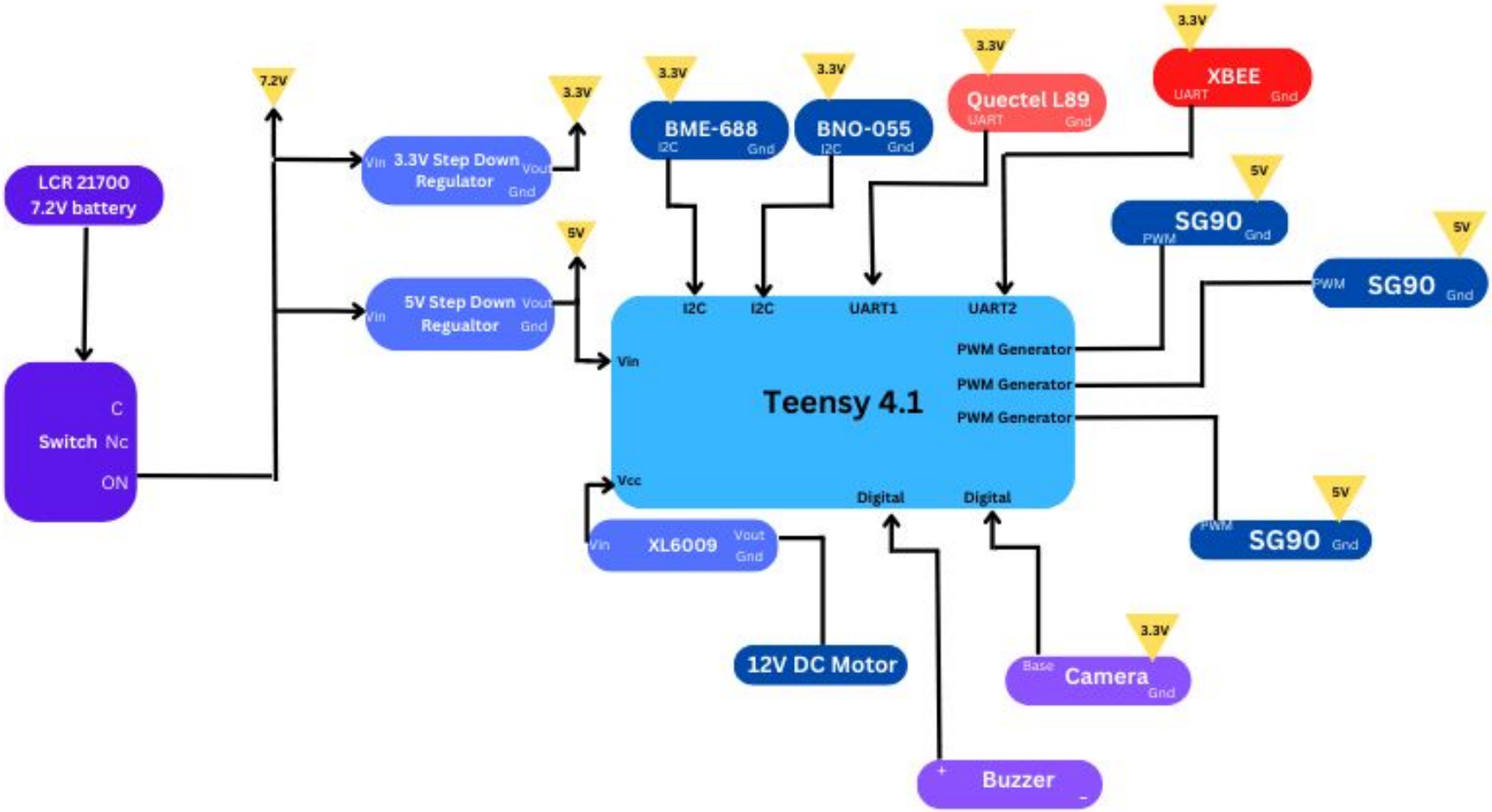
EPS Overview

Components	Purpose
Power	1.HEB 3.7V 6800mah lcr-21700 V battery is used to supply power to all components in the container. 2. A power switch (external on/off switch) will be used to connect or disconnect the power and also used to reset the container. 3. 2 Batteries are used and connected in series .
Regulators	1 The 5V regulator is used to supply to motors 2.The 3.3V regulator is used to supply all sensors and XBEE in the container.
MCU	1. Teensy 4.1 will collect all data sensors and drive all actuators. 2. SD Card will save all sensors data and recordings from camera .

Changes Made from PDR

Name	PDR	CDR	Rationale
Battery	Ultrafire BRC 18650	HEB 3.7V Icr-21700 V	Suggested by reviewers in PDR Presentation .

Electrical Block Diagram



Power Source

Battery Model	Battery Type	Quantity	Configuration	Size	Mass	Supply Voltage	Charge	Max Continuous Discharge	Cost
Ultrafire BRC 18650	Li-ion	2	Series	6.6*1.8*1.8(cm)	96g	7.4V	12000	1.5A	234.82

Power Budget

	Supply Voltage	Current	Power (W-h)	Power Consumption	Duty Cycle	Data Reference
Teensy 4.1	3.3V	100mA	0.33W	0.00033	100%	Datasheet
BME-688	3.6V	3.9mA	0.108W	0.00001404	100%	Datasheet
XBEE	3.3V	295mA	0.974W	0.000974	100%	Datasheet
SG90(*3)	5V	250mA	1.25W	0.00125(*3=0.00375)	5%	Datasheet
12V DC Motor	12V	300mA	3.6W	0.0036	100%	Datasheet
Buzzer	5V	80mA	0.4W	0.0004	100%	Datasheet
SG90	5V	360mA	1.8W	0.0018	100%	Datasheet
Bno-055	3.6V	20mA	0.072W	0.000072	100%	Datasheet
Quectel L89	3.3V	35mA	0.1155W	0.0001155	100%	Datasheet
X-Bee	3.3V	40mA	0.132W	0.000132	100%	Datasheet
Total				0.00868754kW	Margin	0.09195246kW
Battery	7.4V	13600mA		0.10064kW	Time	10 Hours 34 Minutes

Flight Software (FSW) Design

Presenter Name(s) Go Here

FSW Overview

- **Overview of the CanSat FSW design**
- **Should discuss**
  - Basic FSW architecture, a flow chart showing how the software flow
  - Programming languages
  - Development environments
  - Brief summary of the FSW tasks
  - Differences between Container and Payloads

FSW Changes Since PDR

- **Overview of the CanSat FSW changes since the PDR. Details of the changes should be discussed in subsequent slides.**

Payload CanSat FSW State Diagram

- **Software state diagrams for Payload defining the *states* and *transition conditions* of the flight software**
- **Include:**
  - Sampling of sensors (including rates)
  - Communications (command and telemetry)
  - Data storage (if applicable)
  - Mechanism activations
  - Major decision points in the logic
- **FSW recovery to correct state after processor reset during flight**
  - What data is used to recover?
  - **Identify reasons for reset, and methods of recovery**

Simulation Mode Software

- Describe the implementation of simulation mode where simulated pressure sensor data is transmitted to the container so simulate the mission
- Describe simulation mode commands
- How is simulated sensor data substituted with real data?
- See the competition guide for detailed requirements

Software Development Plan

- **A common CanSat problem is late software development**
- **Present a slide describing the plan for software development and plans to reduce the risk of late software development**
- **Include:**
  - Prototyping and prototyping environments
  - Software subsystem development sequence
  - Development team
  - Test methodology
- **Discuss progress since PDR**

Ground Control System (GCS) Design

Presenter Name(s) Go Here

GCS Overview

- **Include a simple context diagram showing major components (computers, antenna, adaptors, etc.)**

GCS Changes Since PDR

- **List changes to the GCS subsystem since PDR. Details of changes should be discussed in subsequent slides.**

GCS Design

- **Show diagram of ground station**
  - What components and how they connect
- **Specifications**
  - How long ground station can operate on battery
  - Overheating mitigation (how do you keep laptop from getting so hot, it stops operating? Remember, it will be hot and the ground station will be in the open sun.)
  - Auto update mitigation (how do you keep the OS from starting an update during operations? It has happened before with Windows OS)

GCS Antenna

- **Discussion of the selection of the GCS antenna**
- **Make sure to include:**
  - Antenna construction, portability, and coverage
    - Diagram is recommended
  - Antenna compliance with hand-held requirement
  - Distance link predictions and margins

GCS Software

- **Telemetry display screen shots**
  - How will Telemetry be displayed in real time and how will it be recorded?
- **Commercial off the shelf (COTS) software packages used**
- **Real-time plotting software design**
- **Command software and interface**
- **Simulation mode**
  - Describe how the ground system reads the profile and transmits simulation commands
- **Progress since PDR**

CanSat Integration and Test

Presenter Name(s) Go Here

Team Logo Here (If You Want)

CanSat Integration and Test Overview

- Discuss subsystem level testing plans
- Discuss integrated level functional testing plans
- Discuss environmental testing plans

Team Logo
Here
(If You Want)

Subsystem Level Testing Plan

- **Discuss plans for testing each subsystem**
  - Sensors
  - CDH
  - EPS
  - Radio communications
  - FSW
  - Mechanical
  - Descent Control

Team Logo Here (If You Want)

Integrated Level Functional Test Plan

- **Discuss tests to be performed after Payload and container are built**
  - Descent testing
  - Communications
  - Mechanisms
  - Deployment
  - Simulation

Team Logo Here (If You Want)

Environmental Test Plan

- **Discuss plans for environmental testing**
  - Drop test
  - Thermal test
  - Vibration test
  - Fit Check
  - Vacuum test

Test Procedures Descriptions

Test Proc	Test Description	Rqmts	Pass Fail Criteria
1	How is test performed and results expected.	1, 2, 45, etc.	
2			
3			
⋮			

- ***For each of the tests specified on the previous slide*, complete this table to describe the procedures to be used**
- **All Mission Requirements should be mapped to a test**
- **Pass / Fail criteria should be clear**

Team Logo
Here
(If You Want)

Simulation Test Plan

- **Discuss plans for simulation testing**
  - What parts of the cansat get tested during simulation
  - How is the simulation implemented

Mission Operations & Analysis

Presenter Name(s) Go Here

Overview of Mission Sequence of Events

- **Launch-day sequence of events**
  - Should start with arrival at the launch site and proceed through recovery and data analysis
- **Include:**
  - Flowchart of events
  - Team member roles and responsibilities
  - Antenna construction and ground system setup
  - CanSat assembly and test
  - Delivery of telemetry data file to field judge for review

Field Safety Rules Compliance

- **Discuss development and content of the Missions Operations Manual for your CanSat**
  - The Mission Operations Manual is due at the Flight Readiness Review the day before launch
    - Assemble in three ring binder (the launch site may be windy)
- **Discuss development status**

CanSat Location and Recovery

- **Discuss how you will find your CanSats in the field**
  - Discuss container and payload recovery
  - Color selection of visible components
  - CanSat return address labeling
    - On both container and payload

Mission Rehearsal Activities

- **Description of mission operations rehearsal activities including:**
  - Details of activities rehearsed to date
    - Ground system radio link check procedures
    - Powering on/off the CanSat
    - Launch configuration preparations (e.g., final assembly and stowing appendages)
    - Loading the CanSat in the launch vehicle
    - Telemetry processing, archiving, and analysis
    - Recovery
- **Description of written procedures developed/required**

The purpose of this section is to summarize and cross reference the compliance to the CanSat Competition Mission Guide requirements.

Requirements Compliance

Presenter Name(s) Go Here

Requirements Compliance Overview

- State current design compliance to requirements
- Summarize content of the detailed slides that follow
- If the design does not comply to the requirements, that is a serious issue – why?

Requirements Compliance (multiple slides, as needed)

- **Provide a table demonstrating compliance to all competition base requirements**
  - Use the following format in as many slides as required

Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
1	Total mass of the CanSat (science payload and container) shall be 500 grams +/- 10 grams.	Comply	x, y, z	Everything should be green by CDR.
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	--	--	--
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	Partial		Medium problem: why?
4	The container shall be a fluorescent color; pink, red or orange.	No Comply		*Big problem: why?*
5	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.			
6	The rocket airframe shall not be used as part of the CanSat operations.			

Use the Green (Comply), Yellow (Partial Compliance), and Red (No Comply) color codes as shown in the examples above for each requirement

Management

Presenter Name(s) Go Here

Status of Procurements

- **Provide status of sensor and component procurements**
  - What has been ordered, when it arrives, etc.
  - This should include flight and GCS hardware (and software if being ordered)
- **This information should be reflected in the overall schedule**

CanSat Budget – Hardware

- **Provide a table listing the costs of the CanSat flight hardware**
- **Table should include**
  - Cost of each components and hardware
  - Indication of whether these costs are actual, estimates, or budgeted values
  - Indication of hardware re-use from previous years
    - The current market value for re-used components should be included
    - Current market value of any free components, materials and services
  - *Total expenses and compare to requirement(s)*

CanSat Budget – Other Costs

- **The goal(s) of this budget are**
  - To provide an understanding of the overall design and development costs
  - Get the teams thinking about the overall costs including necessary funds for travel
  - Identify shortfalls in the budget that require attention
    - In the past some teams have not been able to attend the competition due to a lack of funds
    - If caught early enough, there are a number of resources for funding that may available to teams
- **Table(s) (same format as Hardware Budget) showing**
  - Ground control station costs
  - Other costs
    - Prototyping
    - Test facilities and equipment
    - Rentals
    - Computers
    - Travel
  - Sources of income
- **THE COMPETITION DOES NOT PROVIDE ANY DEVELOPMENT FUNDING OR DONORS**

Team Logo Here (If You Want)

Program Schedule Overview

- **A one page Gantt summary chart showing task start and stop dates and durations shall be presented**
  - Schedule should include linkages between tasks to provide the team with an idea of what happens in the overall flow when milestones are not met on time
- **Make sure the schedule is readable in the presentation**
  - Failure to do so will result in a loss of points

Team Logo Here (If You Want)

Detailed Program Schedule

- **Details of development schedule to include**
  - Competition milestones
  - Academic milestones and holidays
  - Major development activities with assignments
  - Component/hardware deliveries
  - Major integration and test activities and milestones
  - Team member vacations
- **This can be presented in Gantt chart or table format**
- **The goals of this schedule are to**
  - Provide a tool for the team to track progress of CanSat design and development
  - Provide tool for judges to assess trouble areas and offer ways for the team to best meet the objectives of the competition
- **Make sure the schedule is readable in the presentation**
  - This may require the schedule to be broken between multiple slides
    - Failure to do so will result in a loss of points

Shipping and Transportation

- **Discuss plans for shipping/transporting the CanSat hardware to the launch site**
- **In past competitions, CanSat hardware checked with airlines was *lost***
  - Consider options for shipping hardware to the launch site (typical for a satellite and ground system program)
  - Consider carry-on restrictions
  - Consider customs and international regulations
- **Consider shipping/transportation of tools and equipment**

Conclusions

- **Presentation summary and conclusions**
- **In general include the following:**
  - Major accomplishments
  - Major unfinished work
  - Testing to complete
  - Flight software status

Presentation Scoring & Additional Information

Do Not Include the Following Charts in the Presentations

The following slides provide additional information regarding presentation scoring, as well as recommendations for the presentations and slides

Presentation Scoring

- **Each slide in this template is scored on a scale of 0 to 2 points**
  - 0 = missing or no compliance to the intent of the requirement
  - 1 = topic incomplete or partial compliance to requirement(s)
  - 2 = complete and demonstrates requirement(s) met
- **Each section of the presentation (System Overview, Sensor Subsystems, etc.) is weighted according to the table**
- **Each team will receive a link to a summary score sheet that will contain all their competition scores**

PPT Template Use

- **All teams shall use this presentation template**
- **Team logos**
  - A team logo can be inserted into the placeholder location (and size) on the master slide
  - If no logo is to be used, remove the placeholder from the master slide
- **Team number and name must be in the footer of each slide**
- **On each slide, replace the "Name goes here" in the bottom left corner with the name of the person(s) presenting that slide**
  - This will allow the judges to know the person to address any questions or comments to

Presentation Template Update Log (Do not include in presentation)

- **1.0 – Initial version for 2023**